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(54) Mercury vapor discharge lamp.

(57) There are provided a mercury discharge lamp that contains an accurate amount of sealed-in mercury in the bulb (1) and a mercury carrier (71) to be used for such a discharge lamp and capable of stably maintaining the mercury as well as to an efficient method of manufacturing the same. A mercury vapor discharge lamp according to the invention comprises a mercury carrier (71) that retains in it a given amount of mercury which is discharged into the bulb (1) of the lamp. Said mercury carrier (71) comprises a porous carrier main body made of an appropriate material such as a ceramic material. The carrier main body is prefabricated and immersed in liquid silver under pressure to drive mercury into the gaps formed in the carrier main body, where it is retained.

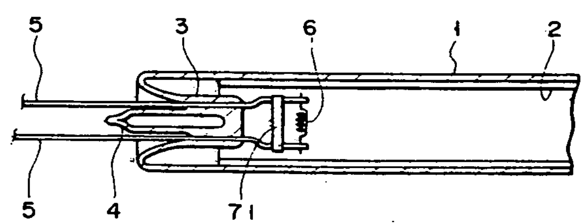

FIG. 1

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This invention relates to a mercury vapor discharge lamp and a mercury carrier to be used for such a discharge lamp as well as to a method of manufacturing the same. More particularly, the present invention relates to a mercury discharge lamp that contains an accurate amount of sealed-in mercury and a mercury carrier to be used for such a discharge lamp and capable of stably maintaining the mercury as well as to an efficient method of manufacturing the same.

A mercury vapor discharge lamp such as a so-called fluorescent lamp has a bulb which is hermetically sealed and contains mercury vapor in it. The amount of sealed-in mercury in the bulb should be accurately controlled so that the lamp may properly work. If the amount of sealed-in mercury in the bulb is smaller than the proper value, the lamp would fall short of the intended output level and service life.

Conventionally, a mercury doser is used to deliver a given amount mercury into a bulb. A mercury doser is an apparatus having a small nozzle through which a given amount of mercury is discharged and poured into a bulb for each operation. Since mercury has a large surface tension, however, the mercury discharged from the nozzle can easily cohere to become globular, making the amount of mercury to be poured into the bulb not precisely controllable.

Therefore, when mercury is delivered into bulbs by means of a mercury doser as described above, it is a common practice to pour an excessive amount of mercury into each bulb in order to compensate a possible error in terms of the amount of delivered mercury which often falls short of the necessary level. Then, the excessive mercury easily adheres to the inner surface of the bulb in small particles to damage the appearance of the lamp and significantly reduce the intensity of light emitted from the lamp. When the bulb of a discharge lamp containing an excessive amount of mercury is destroyed after its service life, it can contaminate the environment so much more than a bulb containing just a correct amount of mercury.

In an attempt to avoid this problem, there has been proposed a technique of delivering mercury into bulbs in the form of solid mercury amalgam so that the amount of mercury to be poured into a bulb can be rigorously controlled. The sealed-in mercury amalgam in the bulb is then decomposed and evaporated by the heat generated in the bulb when the lamp is energized.

The amalgam is heated, it discharges mercury vapor until the partial pressure of the mercury vapor in the bulb reaches a threshold value, when the inside of the bulb is saturated with mercury vapor and the discharge of mercury vapor stops. The saturation vapor pressure of mercury is a function of temperature and rises as the temperature in the bulb goes up. When the lamp is deactivated, therefore, the pressure of mercury vapor in the bulb is low. The pressure may be further reduced when the temperature of ambient air is low and become so low that the lamp would not be activated if the switch of the lamp is turned on. Besides, mercury amalgam is normally costly to make the cost of discharge lamps containing such amalgam rather high.

In order to eliminate the problem that accompanies the use of mercury amalgam, a method of using a mercury carrier has been devised and disclosed in Japanese Patent Disclosure Tokkai Shou No. 62-180933. A mercury carrier disclosed in the document is prepared by mixing mercury and fine particles of a metallic material such as iron or an iron-nickel alloy that does not form an amalgam with mercury, compressing the mixture of mercury and metallic fine particles in a mold to force out any excessive mercury and bonding the metallic particles together under pressure to make the mixture very solid. A mercury carrier prepared in this way contains liquid mercury in the gaps formed among the pressure bonded metallic particles. The saturation vapor pressure of mercury discharged from such a mercury carrier is relatively high and hence a mercury vapor discharge lamp comprising such a mercury carrier is free from the amalgam-related problem as described above.

However, a mercury carrier having a configuration as described above has a disadvantage that its mechanical strength is relative low and therefore subject to damage during transportation and handling. It is also accompanied by a disadvantage that it can only poorly hold liquid mercury in the gaps among the metallic particles and therefore the liquid mercury contained in the gaps can ooze out onto the surface of the carrier during storage and handling.

It is therefore the object of the present invention to provide a mercury vapor discharge lamp and a mercury carrier to be used for such a discharge lamp as well as a method of manufacturing the same.

According to the invention, there is provided a mercury carrier to be used for a discharge lamp comprising a porous carrier main body made of an inorganic material such as metal or ceramic. The carrier main body is prefabricated and the air contained in the gaps of the main body is removed in vacuum before it is immersed in a volume of liquid mercury, which is compressed until the gaps in the carrier main body are filled with mercury.

A mercury carrier prepared in this way has an enhanced mechanical strength and the amount of mercury with which the gaps in the mercury carrier main body is filled can be rigorously controlled so

that it may securely hold the mercury in it.

A mercury vapor discharge lamp prepared by using a mercury carrier according to the invention contains in its bulb an accurate amount of mercury and therefore operates very well. In a preferred embodiment of the mercury vapor discharge lamp of the present invention, a mercury carrier is placed close to the electrodes of the discharge lamp so that it may discharge mercury vapor into the bulb by the heat generated in the bulb when the lamp is energized. In another preferred embodiment of the invention, the mercury carrier is put into a exhaust pipe of the discharge lamp so that it may discharge mercury vapor into the bulb by the heat generated when the exhaust pipe is pinch-sealed.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of a first embodiment of the mercury vapor discharge lamp of the invention;

Fig. 2 is a longitudinal sectional view of a second embodiment of the mercury vapor discharge lamp of the invention;

Fig. 3 is a longitudinal sectional view of a third embodiment of the mercury vapor discharge lamp of the invention;

Figs. 4 and 5 are longitudinal sectional views of a fourth and fifth embodiments of the mercury vapor discharge lamp of the invention, showing as well the method of manufacturing the same;

Fig. 6 is an enlarged partial sectional view of a mercury carrier according to the invention;

Fig. 7 is a schematic perspective view of a first embodiment of the mercury carrier of the invention;

Fig. 8 is a schematic perspective view of a second embodiment of the mercury carrier of the invention;

Fig. 9 is a schematic perspective view of a third embodiment of the mercury carrier of the invention;

Fig. 10 is a graphic illustration of the accuracy of the mercury holding capacity of mercury carriers according to the invention shown in comparison with that of conventional mercury carriers; and

Fig. 11 is a graphic illustration of the performance with time of mercury vapor discharge lamps according to the invention and that of conventional mercury vapor discharge lamps.

Fig. 1 illustrates a first embodiment of the mercury vapor discharge lamp of the invention, which is in fact a fluorescent lamp and has a straight tubular bulb 1. The inner surface of the bulb 1 is coated with a fluorescent film 2. A stem 3 is sealed in an end of the bulb 1 and an exhaust pipe 4, a pair of lead wires 5, 5 and filament electrodes 6 are securely fitted to the stem 3. A mercury carrier 71 is securely fitted to the lead wires 5, 5 near the filament electrodes 6.

As shown in Fig. 7, the mercury carrier 71 is realized as an oblong and flat plate. The mercury carrier 71 is constituted by a carrier main body 63, which is made of a porous inorganic material. The carrier main body 63 is prepared by sintering a body of aggregated particles 61 of an inorganic material and contains small drops of liquid mercury in the gaps 61 formed by neighboring particles 61 of the carrier main body 63. The drops of mercury are held in there because of their surface tension.

Materials that can be used for preparing the particles 61 include ceramic materials such as aluminum nitride, aluminum oxide, silicon oxide, titanium oxide, zirconium oxide, yttrium oxide and vitreous materials. A carrier main body 63 formed by particles 61 of a ceramic material is electrically highly insulating and therefore can block any electricity trying to flow through the mercury carrier 71 constituted by the main body 63 and arranged between the two lead wires 5, 5 as shown in Fig. 1.

Materials that can be used for preparing the particles 61 also include metallic materials. When a carrier main body 63 is formed particles 61 of a metallic material, the mercury carrier 71 constituted by such a main body 63 is preferably fitted to a glass section of the stem button of the stem 3 as shown in Fig. 2. With such an arrangement, the lead wires 5, 5 are protected against short-circuiting that can be caused by the conductive mercury carrier 71.

When a fluorescent lamp having a configuration as described above is turned on, electricity flows through the filament electrodes 6 to generate heat there, which by turn heats the mercury carrier 71. The heated mercury carrier 71 eventually discharge mercury vapor into the bulb 1.

Once the mercury carrier 71 has discharged the mercury it used to contain into the bulb 1, it would never adsorb the vapor mercury even when the temperature in the bulb 1 is lowered. On the other hand, the carrier main body 63 of the mercury carrier 71 that has discharged the mercury it used to contain is a porous object having a large surface area and hence has a strong adsorbent effect. Therefore, a carrier main body 63 acts as a getter that effectively adsorb gaseous impurities in the bulb 1 after it has discharged the mercury it used to contain. The effect of the getter will be particularly large when a vitreous material is used for the particles 61.

As a porous mercury carrier constituted by a carrier main body 63 as described above is prepared by sintering an aggregate of fine particles

61, they are firmly bound together to make the mercury carrier 71 mechanically very strong. Consequently, the mercury carrier 71 can be hardly damaged while it is being handled.

Since the carrier main body 63 of a mercury carrier 71 according to the invention contains mercury in the gaps within it, the amount of mercury contained in it can be accurately controlled. This means that, when properly controlled, a mercury carrier 71 according to the invention contains no excessive mercury that can ooze out from the gaps 61 where it is stored and come to the surface.

A mercury carrier 71 according to the invention can be manufactured in the following manner. Firstly, a given amount of a granular material is mixed well and compressed in a mold. The molded material is then sintered to form a carrier main body 63 that constitutes a mercury carrier 71.

Thereafter, the carrier main body 63 is heated in steam or a gaseous mixture of steam and hydrogen to remove carbon and other unnecessary substances contained in it. The carrier main body 63 is further heated in vacuum to eliminate moisture and other impurities contained in it as well as air stored in the gaps of the main body. Then, the carrier main body 63 is immersed in liquid mercury in a vacuum chamber and the liquid mercury is put under pressure to a given pressure level. The pressure drives small drops of mercury to get deep into the gaps of the carrier main body 63, where they are retained because of their surface tension.

The size and the density of distribution of the gaps in the carrier main body 63 can be controlled by selecting the particle size of the material of the carrier main body 63 and the bulk density of the molded material. Moreover, the extent to which the gaps are filled with mercury can be controlled by selecting the pressure applied to the liquid mercury in the vacuum chamber. Thus, it will be understood that the total amount of mercury to be contained in the gaps of a carrier main body 63 and the force applied to the mercury drops contained in the gaps of a carrier main body 63 to hold them there can be rigorously controlled by controlling those parameters. Such a capability of rigorously controlling the amount of mercury to be contained in the gaps of a carrier main body as well as the force to retain the mercury drops in the gaps of a carrier main body can not by any means be found in a known method of manufacturing mercury carriers. Thus, a mercury carrier according to the invention and manufactured by a method according to the invention would never show mercury oozing out from inside onto the surface if the temperature of ambient air violently fluctuates.

The carrier main body of a mercury carrier according to the invention is not necessarily made of any of the above listed materials. For instance, it may be alternatively made of an inorganic material including glass and various metals.

The method of manufacturing porous carrier main bodies is not limited to the one as described above. When glass is used as a material for manufacturing carrier main bodies, for instance, sodium chloride is dissolved in molten glass and then the glass is solidified to deposit sodium chloride that has been dissolved in the glass. A piece of a porous material to be used for carrier main bodies is produced when the deposited sodium chloride is removed from the glass.

Alternatively, a piece of a porous material may be prepared by forming fine gaps in a homogeneous piece of a material such as glass or metal by means of a machine cutter, laser or an electronic beam.

Nor the form of a fluorescent lamp to be realized by using a mercury vapor discharge lamp according to the invention is limited to the above described two embodiments. A third embodiment of the present invention as illustrated in Fig. 3 is in fact a fluorescent lamp realized by introducing a mercury carrier 72 according to the invention into an exhaust pipe 4 of a stem 3. The mercury carrier 72 in the fluorescent lamp is heated to discharge mercury into the bulb 1 when the exhaust pipe 4 is pinch-sealed. Since the mercury carrier 72 is housed in an exhaust pipe 4 which is not heated so hot when the lamp is energized, it operates effectively as a getter for catching impurities in the lamp once it has discharged the mercury it used to contain.

A mercury carrier 72 to be introduced into an exhaust pipe 4 has preferably a cylindrical form as illustrated in Fig. 8.

A mercury carrier according to the invention may be alternatively a spherical mercury carrier 73 comprising small particles as illustrated in Fig. 8. When a mercury carrier is realized in such a form, one or more than one mercury carriers may be housed in a single exhaust pipe 4.

Figs. 4 and 5 show a fourth embodiment of the mercury vapor discharge lamp of the invention. In this embodiment, a mercury carrier 72 is housed in an exhaust pipe and, after discharging the mercury contained in the carrier, both the mercury carrier 72 and the exhaust pipe are totally removed out of the lamp. More specifically, a mercury carrier 72 is introduced into a front end portion of an exhaust pipe 4 and the passage through which the mercury carrier 72 is brought into the exhaust pipe 4 is closed and sealed. At this stage, the mercury carrier 72 is caused to discharge the mercury it contains into the bulb 1 by the heat used for sealing the exhaust pipe. Then, as shown in Fig. 5, the exhaust pipe 4 is pinch-sealed at a position closer to the root of the exhaust pipe than that of the

mercury carrier 72 and, thereafter, the front end portion 41 and the mercury carrier 72 housed there are removed from the pipe. Therefore, this embodiment does not have a mercury carrier at all in the bulb when it becomes a finished product.

Some of the results of a series of tests conducted on a number of fluorescent lamps manufactured according to the invention are shown in Figs. 10 and 11.

Fig. 10 illustrates how accurately mercury can be discharged into the bulb of a fluorescent lamp by using a mercury carrier according to the invention. The solid line in the graph of Fig. 10 is obtained by plotting the number of fluorescent lamps using a mercury carrier according to the invention for each amount of mercury contained in the lamps which were tested, whereas the broken line indicates the number of fluorescent lamps containing a given amount of mercury charged with mercury by means of a conventional mercury doser, the amount being variable for the tested lamps. It may be needless to say that fluorescent lamps using a mercury carrier according to the invention show little deviation in terms of the amount of mercury contained there.

Fig. 11 shows how the flux of light of fluorescent lamps using a mercury carrier according to the invention is maintained for a prolong period of time and hence they have a prolonged service life if compared with lamps charged with mercury by means of a conventional mercury doser. The solid line there indicates the average performance of discharge lamps according to the invention whereas the broken line shows how the flux of light of conventional fluorescent lamps declines with time.

Claims

1. A mercury vapor discharge lamp having electrodes arranged within a bulb and containing sealed-in mercury vapor in the bulb, characterized in that it comprises a mercury carrier (71, 72, 73) arranged within said bulb (1), said mercury carrier comprising a porous carrier main body (63) made of an inorganic material, said mercury being held in gaps (62) formed in said main body.

2. A mercury vapor discharge lamp according to claim 1, characterized in that said mercury carrier (71, 72, 73) is fitted to a stem (3) arranged near said electrodes (6).

3. A mercury vapor discharge lamp according to claim 1, characterized in that said mercury carrier (71, 72, 73) is housed in an exhaust pipe (4) communicating with the inside of said bulb.

4. A mercury vapor discharge lamp according to claim 1, characterized in that said carrier main body (63) is made of a porous ceramic material.

5. A mercury vapor discharge lamp according to claim 1, characterized in that said carrier main body (63) is made of a porous vitreous material.

6. A mercury vapor discharge lamp according to claim 1, characterized in that said carrier main body (63) is made of a porous metallic material.

7. A mercury carrier retaining a given amount of mercury within it and designed to discharge said amount of mercury into the bulb of a mercury vapor discharge lamp after having been housed in said bulb, characterized in that said mercury carrier (71, 72, 73) comprises a porous carrier main body (63) made of an inorganic material, said mercury being held in gaps (4) formed in said carrier main body (63).

8. A mercury carrier according to claim 7, characterized in that said carrier main body (63) is made of a porous ceramic material.

9. A mercury carrier according to claim 7, characterized in that said carrier main body (63) is made of a porous vitreous material.

10. A mercury carrier according to claim 7, characterized in that said carrier main body (63) is made of a porous metallic material.

11. A mercury carrier according to claim 7, characterized in that said carrier main body (63) is made of sintered particles of an inorganic material.

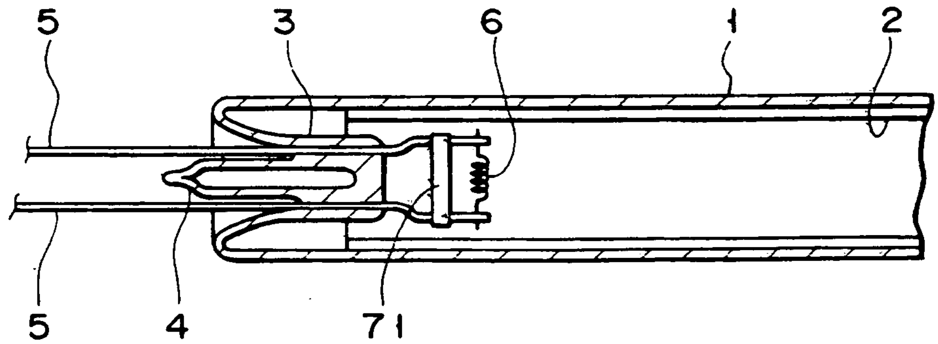
12. A method of manufacturing a mercury carrier retaining a given amount of mercury within it and designed to discharge said amount of mercury into the bulb of a mercury vapor discharge lamp after having been housed in said bulb, characterized in that it comprises a step of prefabricating a porous carrier main body (63) made of an inorganic material and a step of immersing said carrier main body (63) in liquid mercury and applying pressure to the mercury to drive said mercury into gaps (62) formed in the carrier main body (63).

13. A method of manufacturing a mercury carrier according to claim 12, characterized in that a carrier main body (63) having a desired form is

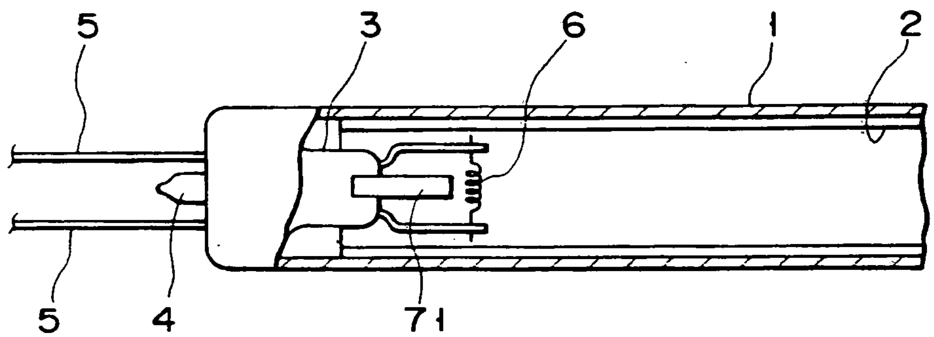
prepared by sintering particles of an inorganic material in said step of prefabricating a porous carrier main body.

14. A method of manufacturing a mercury carrier according to claim 12, characterized in that said step of driving mercury into the gaps of the carrier main body further comprises a step of heating said carrier main body (63) in an steam containing atmosphere to remove carbon and other impurities and a subsequent step of heating said carrier main body (63) in vacuum to remove the remaining impurities and the air trapped in the gaps of the carrier main body (63), the carrier main body (63) being subsequently immersed in liquid mercury under pressure.

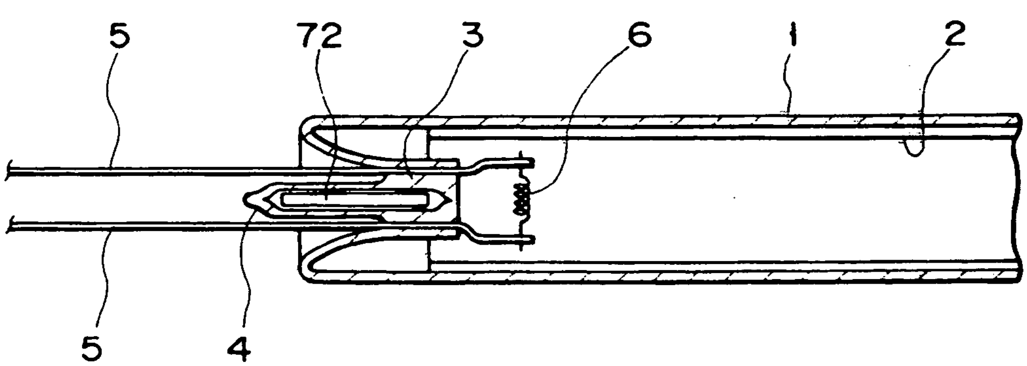
15. A method of manufacturing a mercury vapor discharge having a bulb, electrodes arranged in said bulb and an exhaust pipe communicating with the inside of said bulb, characterized in that it comprises a step of introducing a mercury carrier (72) into said exhaust pipe (4), said mercury carrier comprising a porous carrier main body (63) retaining mercury in gaps formed in it, a step of sealing the front end of said exhaust pipe (4) and heating said mercury carrier (72) to discharge the mercury into the bulb (1) and a step of pinch-sealing said exhaust pipe (4) at a position closer to its root than that of the mercury carrier (72) and subsequently removing said mercury carrier (72) and the front end portion (41) of said exhaust pipe (4) from the bulb.



F I G. 1



F I G. 2



F I G. 3

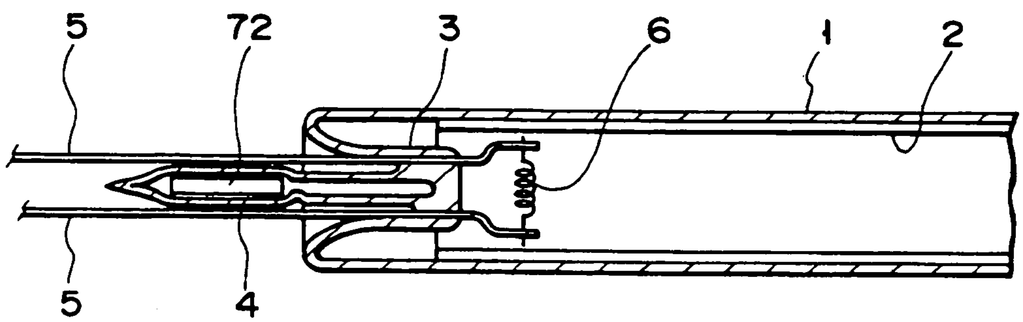


FIG. 4

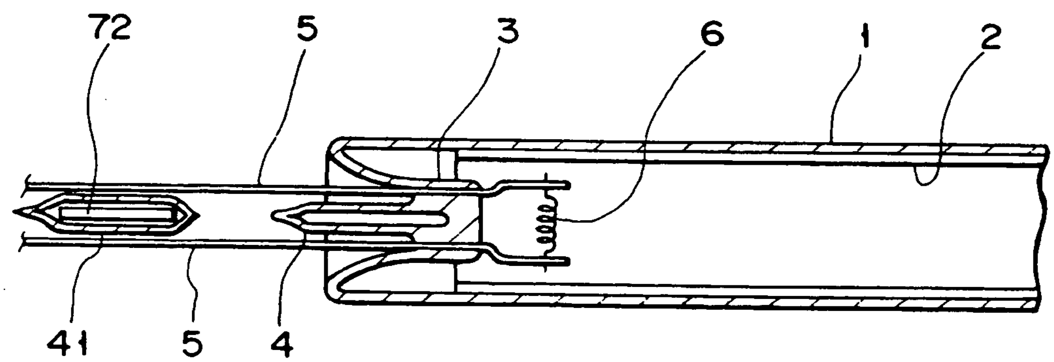
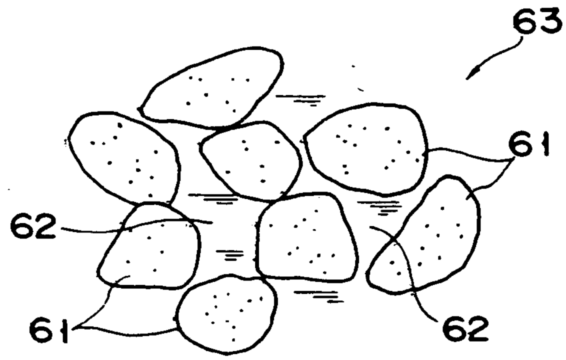
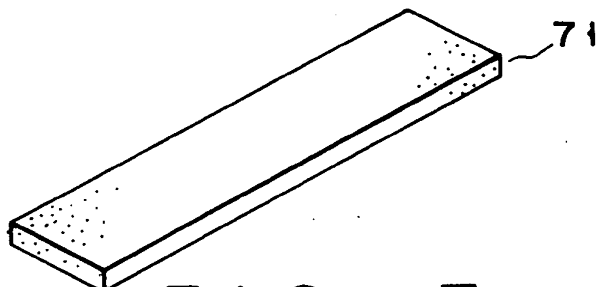


FIG. 5



F I G. 6



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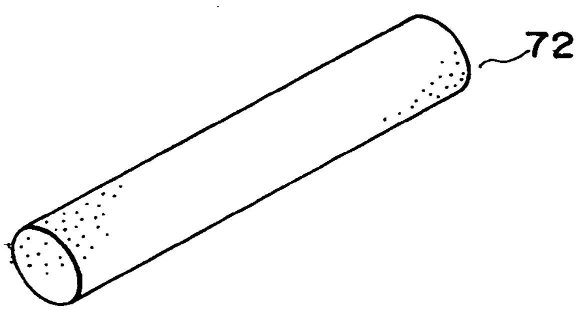

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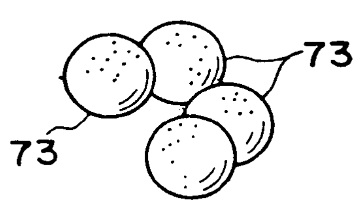

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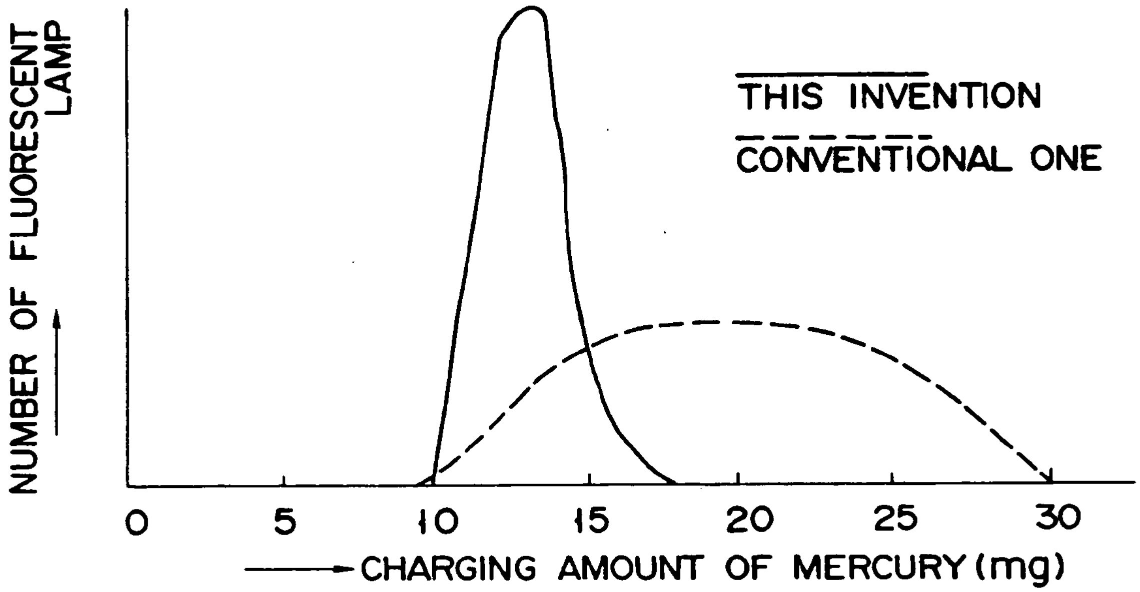
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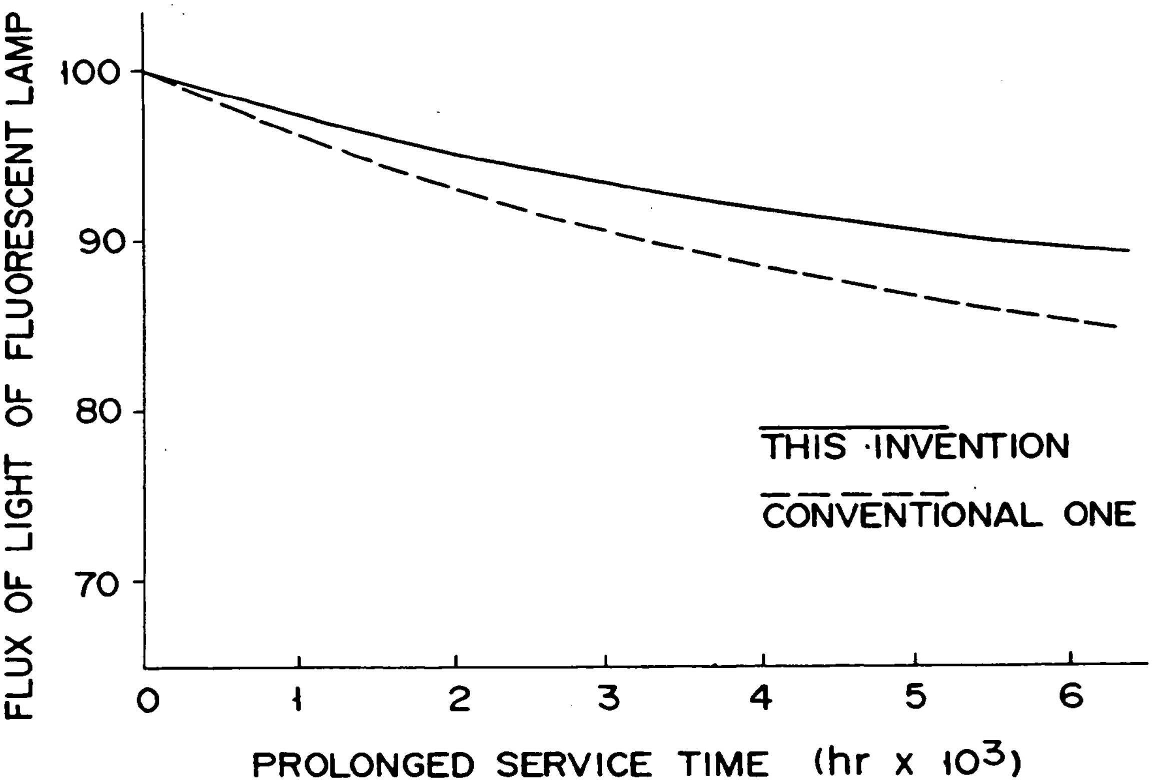
10
15
20
25
30
CHARGING AMOUNT OF MERCURY (mg)

F I G. 10


FLUX OF LIGHT OF FLUORESCENT LAMP
100
90
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THIS INVENTION
CONVENTIONAL ONE
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1
2
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PROLONGED SERVICE TIME (hr x 10³)

F I G. 11

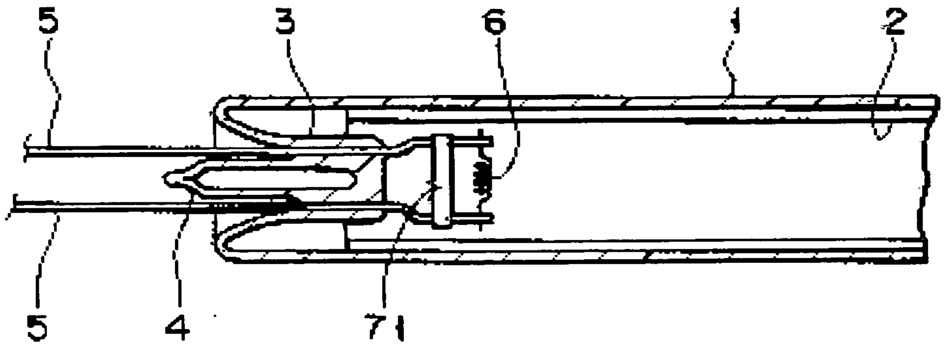


FIG. 1

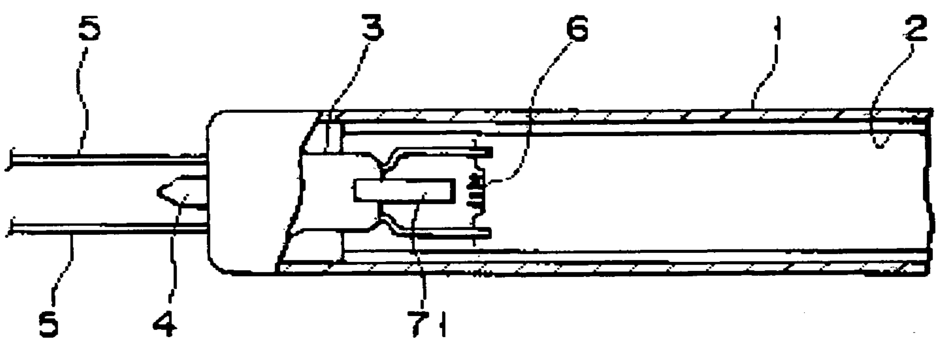


FIG. 2

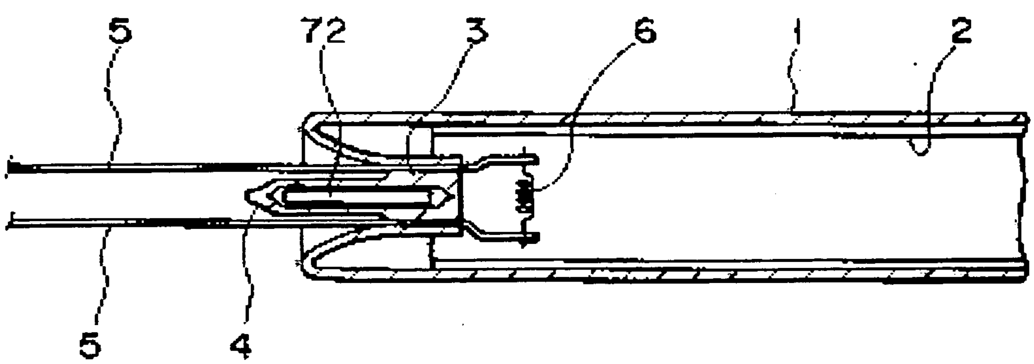
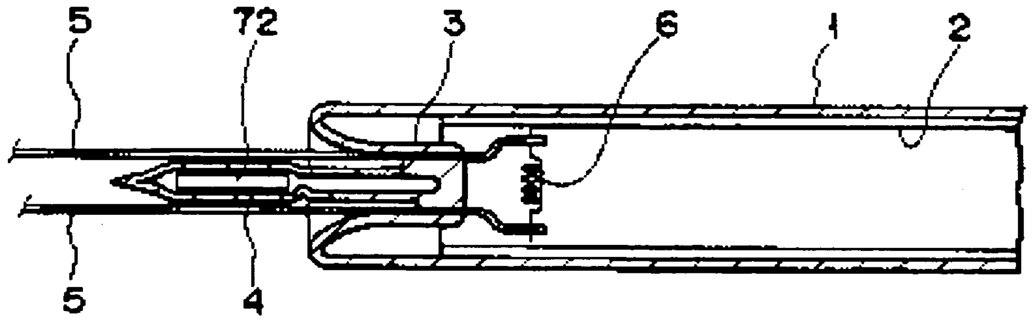
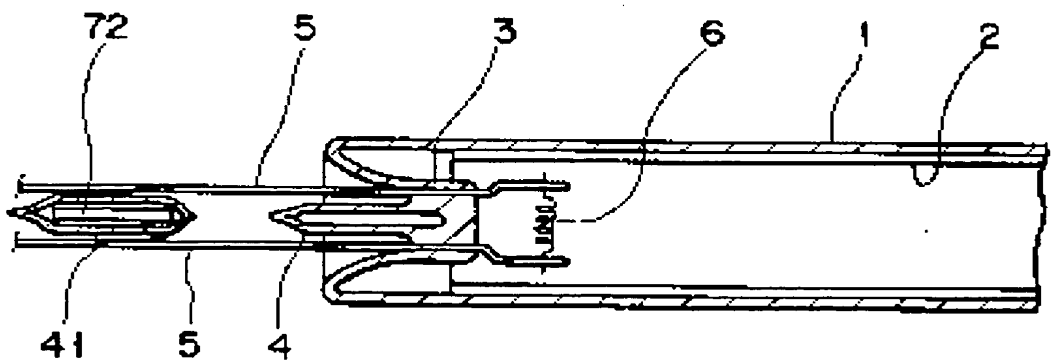


FIG. 3



F I G. 4



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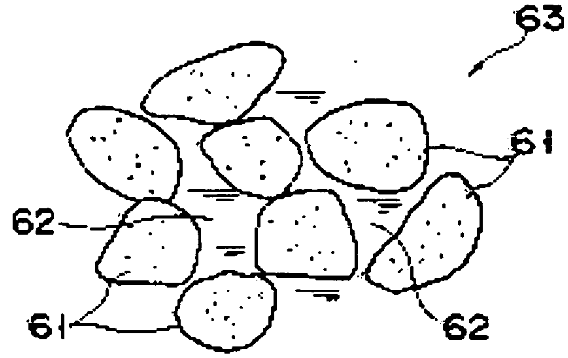


FIG. 6

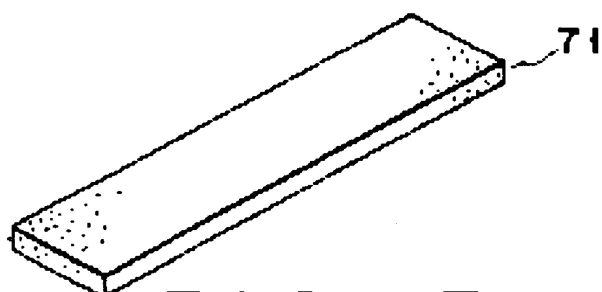


FIG. 7

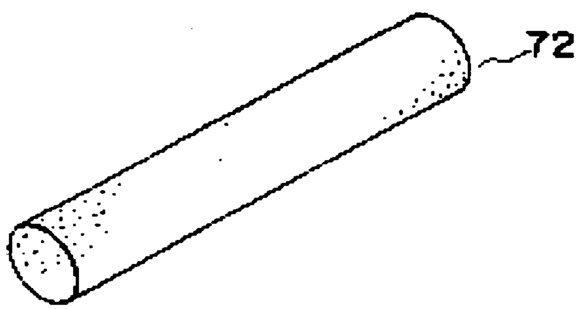


FIG. 8

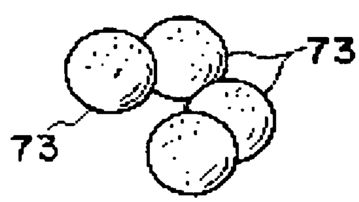
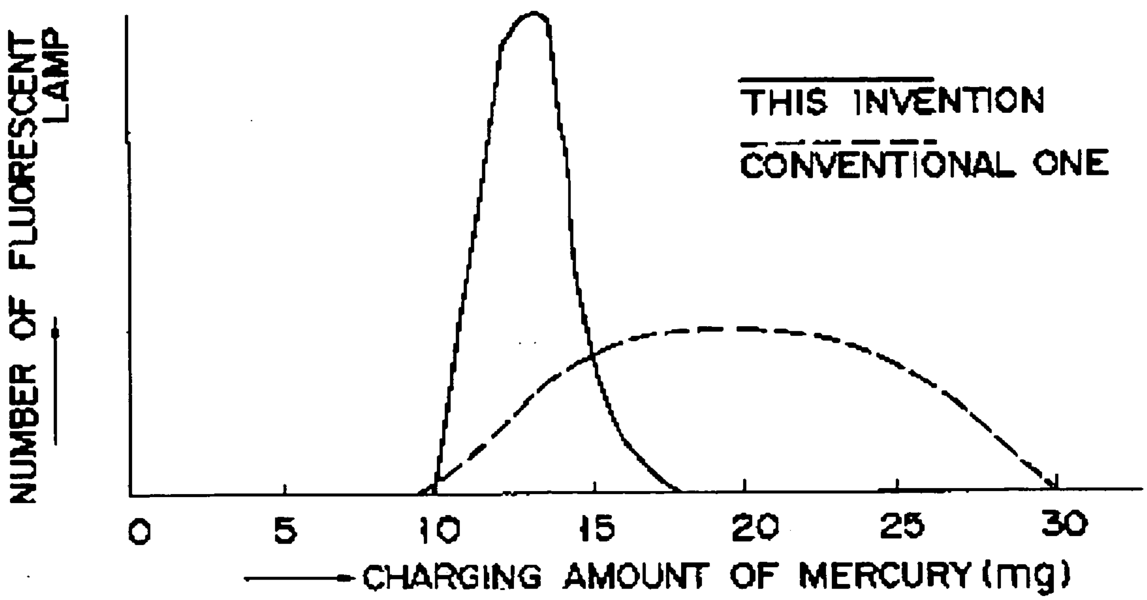


FIG. 9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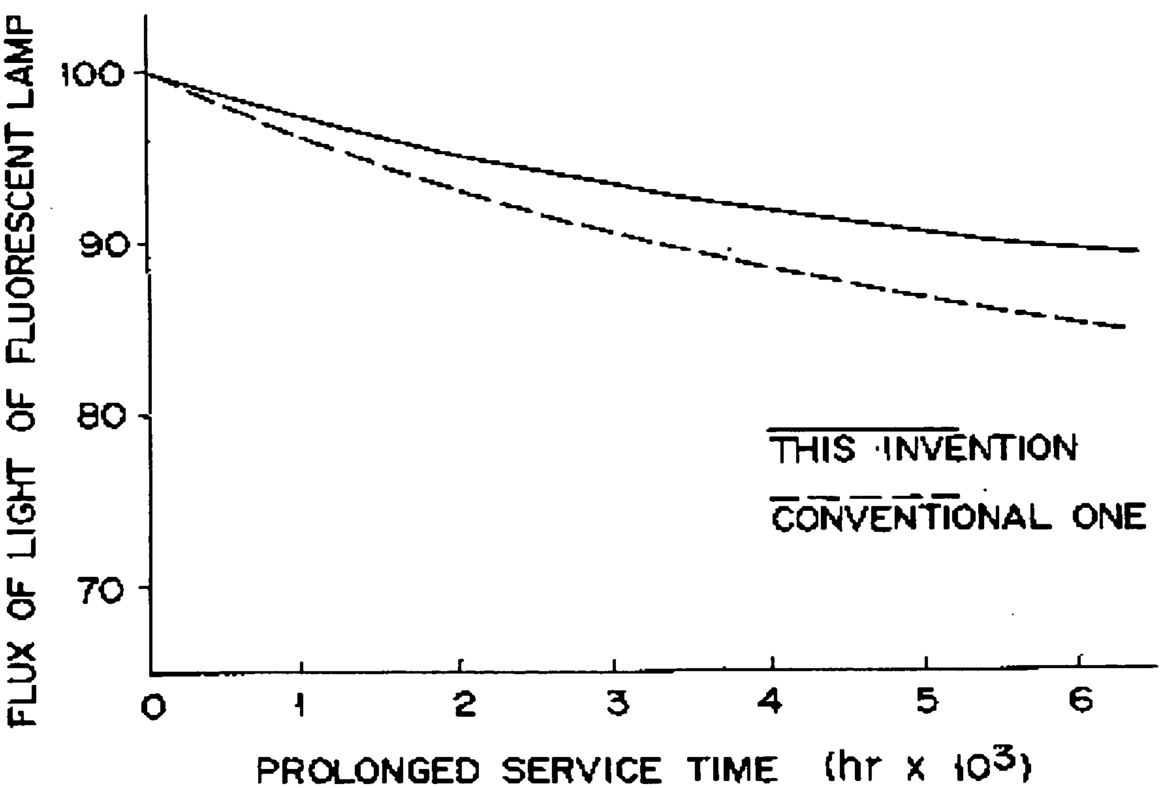
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70
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0
1
2
3
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PROLONGED SERVICE TIME (hr x 10^3)

F I G. 11

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Office uropé n des br vets

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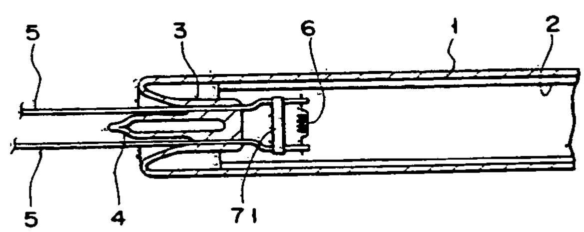
(54) Mercury vapor discharge lamp.

(57) There are provided a mercury discharge lamp that contains an accurate amount of sealed-in mercury in the bulb (1) and a mercury carrier (71) to be used for such a discharge lamp, capable of stably maintaining the mercury, as well as an efficient method of manufacturing the same. A mercury vapor discharge lamp according to the invention comprises a mercury carrier (71) that retains in it a given amount of mercury which is discharged into the bulb (1) of the lamp. Said mercury carrier (71) comprises a porous carrier main body made of an appropriate material such as a ceramic material. The carrier main body is prefabricated and immersed in liquid mercury under pressure to drive mercury into the gaps formed in the carrier main body, where it is retained.



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EP 0 479 259 A3

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 13, no. 534 (E-852)(3882) 29 November 1989 & JP-A-1 220 359 (TOSHIBA CORP) 4 September 1989	1,3,4,7, 8	H01J61/24 H01J9/395
Y		6	
A	* abstract *	11	
X,D	EP-A-0 228 005 (PATENT-TREUHAND-GESELLSCHAFT FUR ELEKTRISCHE GLUHLAMPEN MBH) * abstract *	1,6,7,10	
X	DE-A-2 203 033 (GEBR. HERRMANN)	7,8	
A	* title; page 2, lines 14 - 17 *	1,4,6,10	
Y	US-A-3 825 788 (PFAUE ET AL.)	6	
A	* column 1, line 64 - line 68; claims 1,7 *	1,3,7, 10,11,13	
A	EP-A-0 081 263 (N.V. PHILIPS' GLOEILAMPENFABRIEKEN) * abstract; figures *	2	TECHNICAL FIELDS SEARCHED (Int. Cl.5) H01J
A	EP-A-0 359 724 (SAES GETTERS S.P.A.) * abstract * * column 2, line 58 - line 61 *	1,6,7, 10,11	
A	US-A-4 146 497 (BAROSI ET AL.) * abstract; figure 29 * * column 3, line 59 - line 64 * * column 4, line 51 - line 61 * * column 10, line 19 - line 38 *	1,4,6-8, 10,12	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 MARCH 1992	MARTIN Y VICENTE M.

CATEGORY OF CITED DOCUMENTS

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-2 892 665 (FRASER) * column 1, line 54 - column 2, line 12; figures 1,2 *	15	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

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